Workshop on
Electric Utilities and Water: Emerging Issues and R&D Needs
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Appendix C
BREAKOUT SESSION B PARTICIPANTS

Name	**Organization**
Terry Ackman	NETL
Richard Bajura	NRCCE – WVU
Carl Bauer	NETL
Charryl Berger	LANL
Lynn Brickett	NETL/EPD
Tim Connor	US EPA
Tom Feeley	NETL
Sarah Forbes – Scribe	NETL/OSPS
Robert Gross	NETL/OSPS
Mike Hightower	Sandia Labs
Jerry Hill	SSEB
Jeff Hoffmann– Scribe	SAIC
Debra Littleton	DOE/FE
Daniel Macuga	LANL
Kanwal Mahajan	NETL
Wayne Micheletti	Wayne C. Micheletti, Inc.
Dick Mulik – Scribe	SAIC
Massood Ramezan – Moderator	SAIC
Patrick Renshaw– Spokesman	PPL Generation
Bob Robey	GTI
Paul Spence	GAI Consultants
John Spitznagel	Seimens Westinghouse Power Corp.
Ed Steadman	EERC
John Veil	Argonne National Laboratory
Kent Zammit	EPRI

Session Objectives

- Identify and discuss current and emerging water issues impacting electricity generation
- Identify key technical and scientific RD&D opportunities for industry-government partnerships

Summary of Issues and R&D Needs

Technical and Operational Needs for Cooling and Process Water Needs – The underlying theme was that in order to meet likely increased demand needs, cost-effective, innovative cooling technologies and new water sources will be necessary.

- Alternative water sources need to be investigated. Look for non-traditional water sources, including industrial reuse, to ensure adequate water availability and reduce competition for fresh water resources.
- Use DOE expertise in available degraded waters (quantity & quality data) to develop both a national database as well as suitable treatment options for degraded waters.
- Reduce thermal pollution of power plant discharges.
- Cost effectiveness is extremely important. In a deregulated industry, utilities won't build unless they have economical access to transmission, fuel, and water supplies.

Innovative Approaches – The group spent some time discussing potential options for alternative cooling technologies as well as potential alternative sources of water to meet cooling and process needs. The group also stressed the need for clear understanding of both specific process water quality needs and characterization of source body water quality. Additionally, the group discussed creative use of power plant discharges including recreational use and potential commercial applications for waste heat discharges.

Innovative water technologies and sources

- Interest exists for the use of underground mine pools to satisfy power plant water needs.
- New heat transfer designs and materials are needed to assist in greater heat flux at a small temperature difference. Better condenser design and possibly different heat transfer fluids are also needed. Balance of plant studies other than cooling cycle issues will need to be conducted.
- Exotic and innovative designs and ideas may help to meet power plant water needs, for example:
  - Air/water cooling tower hybrids
  - Series wet cooling system - dry cooling system applications
  - Cryogenic systems
  - Ocean cooling
- Artificial water storage and recovery in aquifers, such as storm water overflow, may be an option.

- In order to make dry cooling a viable option, power plant economics, associated efficiency penalty, capacity loss, reliability, and even the footprint of dry cooling will need to be addressed.
- Opportunities to switch from traditional to degraded water during droughts may help to reduce competition for limited water resources.

In order to satisfactorily meet cooling and process water needs, alternative source water quality issues need to be identified and addressed:

- Reliable produced water and other alternative water source quantity and quality information is necessary.
- It may be necessary to better determine process and cooling water quality requirements in relation to alternative water sources, to assure alternative water source feasibility.
- Specific equipment performance issues need to be addressed, including scaling issues and the design of materials for long-term reliability.
- Economic issues for the treatment and acquisition of alternative sources will need to be resolved.
- New issues will need to be identified, such as understanding hydrologic issues in terms of recirculation (pumping out of and into abandoned mines) of mine pool waters.
- The variability of alternate water sources, such as source behavior during droughts and wastewater storage and quality of combined sewer overflows, will need to be addressed.

Develop creative and innovative uses of process wastewater.

- Explore beneficial use process waste-heat, for example in heating facility buildings.
- Creation of fish hatcheries and/or habitat, both as a beneficial use of power plant water discharge as well as a method of mitigating cooling water intake structure (CWIS) issues. It may be necessary to recognize the intermittent nature and associated risk of the thermal plume.
- To address issues related to mountaintop mining, explore the opportunities of creating lakes and reservoirs for recreation & cooling.

Current & Future Constraints – Participants discussed current and future issues relevant to meeting cooling and process water needs, as well as potential issues that need to be resolved before innovative and creative solutions can be implemented.

- Challenges of innovative systems: Cost, reliability, long-term vision (pre-competitive research).

- Complex operational controls are necessary for parallel wet-dry systems.
- Population trends and siting issues, with respect to climatic cycles, can have a significant impact on current and future water availability.
- Recycling water for varied uses, such as agricultural, municipal water, and industrial water, would need to be more thoroughly explored.
- There is a need to develop efficient high backpressure turbines so direct dry cooling can be built at lower ITD (initial temperature difference) without a significant energy penalty.
- Droughts can drive change from once through to recirculating systems – An EPA 316(b) study indicated four retrofits from once through to recirculation cooling.
- Retrofitting can be difficult because systems are likely already optimized. Challenges: economic, operations, reduced efficiency.
- Economic picture: Can costs be passed on to consumer?

Effluents and Total Maximum Daily Load (TMDL)/National Pollutant Discharge Elimination System (NPDES) Issues

TMDL– The potential impact and subsequent issues of future implementation of the TMDL program was discussed by the group. Because TMDLs may apply to all contributors, power plants will compete with agriculture and industry for permits. Issues relevant to the control of non-point sources, such as agricultural runoff, may influence regulations applicable to power plant discharges. Additionally, power plant air emissions may trigger TMDLs in other watersheds.

- TMDLs have the potential to impact industry, but because they are not clearly defined, their application is not currently known.
- Depending on how the policy is implemented, it may drive new R&D needs.
- Specific issues that may arise out of TMDL implementation may include river system aspects such as maximum temperature levels and geo-chemistry levels.
- Need alternative water treatment technologies for non-point sources.
- Issues exist relevant to inflow versus outflow. In some cases, water comes out cleaner than it went in.
- Reliable models for basin wide planning will be necessary, including point sources, non-point sources and air deposition.
- Aspects of TMDL trading programs need to be developed. Are their potential credits for zero discharge? Will trading opportunities be watershed specific, regional, or even national?

NPDES

- Because NPDES permits can be complex and can vary from one discharge source to another, it would be useful to develop a generic permit requirement document, such as a handbook for federal, state and/or local requirements.
- NPDES permits sometime require cleaner discharge water than that which is actually withdrawn from the source.
- Alternate water quality monitoring methods may be useful for both pollutant discharges as well as aquatic ecosystem impacts (i.e., micro and macro invertebrates).
- Need to reduce the amount of coal fines and other possible pollutants being discharged into and out of settling ponds.
- Measurement technologies are needed for lower level pollutants such as mercury and arsenic. Additionally, on-line real time measurement technologies for effluent and stack emissions are needed.

Water-Related Permitting/Siting Issues

- There have been projections of increased new power generation, including 1700 new units. An associated 30-40% increase in power plant water demand may also be likely. Can new plants be built using traditional cooling methods? Are there enough available water sources?
- Expiration of existing water rights may become an issue in the future.
- Issues may arise due to the relatively large footprint of recirculating systems, such as available land for retrofits as well as new facility permitting.
- Siting of a power plant for generation and export of electricity may trigger local issues regarding the use of a region's water resources.
- Competitive water use may trigger issues related to interstate compacts.
- Issues may exist between water users and water allocators. An example was given of a lack of communication between a Maryland siting group and water utilization groups.

Research & Development

R&D Needs: Cooling Technology

- Determine the impact that alternative water source characteristics, as well as required water pretreatment processes (e.g., scaling concerns) may have on existing cooling systems as well as determining the needs of advanced/exotic systems.

- Assess the feasibility and associated issues related to the use of mine pools as heat sinks.

- Advances to make dry cooling more efficient and less problematic:
  - Spray enhancement (dry cooling)
  - Materials of construction, optimization of tube configurations for dry cooling

- Determine and overcome technical barriers related to exotic cooling systems:
  - Oceanic cooling
  - Cryogenic cooling
  - Determine the feasibility of closed-loop cooling systems with geothermal heat rejection (geologic heat sink).
  - Passive cooling (hyperbolic and reflective)

- R&D pertaining to reducing the risk of impingement and entrainment of aquatic organisms at cooling water intake structures.

R&D Needs Alternative Water Sources

- Optimize water users with water dischargers. Develop watershed-based partnering between utilities, private sector, and other industries in order to identify and use waste streams. "Co-locate" industrial operations that would use cooling water from power plant before discharge to receiving stream/lake. Additionally, provide for the integration of utilities (e.g. water and power) and population centers.

- Conduct thorough systems studies that accurately profile power plant water demands and cooling requirements in order to identify viable alternative water sources.

- Determine and overcome technical barriers related to the conversion of municipal wastewater to cooling utility cooling water.

- Develop accurate watershed-based models that help to identify potential water sources and needs.

- Develop good economic models that helps to compare the value of water for different uses – create a common scale in order to make sound policy decisions.

- Develop and publish a technical white paper in order to communicate power plant water issues to the utility industry.

R&D Needs Wastewater Controls

- Characterization of new waste streams and subsequent development of appropriate treatment processes may be necessary.

- In some cases, high-volume wastewater streams requiring treatment have very low containment levels ("too clean to clean"). There is a need to develop highly efficient

novel treatment technologies. This is especially appropriate for the removal of trace mercury, arsenic and possibly other metals.

- Arsenic removal technologies may also be necessary for ash ponds.
- The installation of air pollution control devices, such as selective catalytic reduction (SCR), may require mitigation techniques for subsequent nitrification and eutrophication of waste streams.

R&D Needs—Science

- Better watershed characterization technologies will be necessary to meet TMDLs and determine individual point source contributions in addition to non-point source and atmospheric deposition components of waterbody pollution.
- Predictive capabilities for climate cycles would be useful in determining the ability of both conventional water sources and alternative water sources to meet power plant water needs.
- Mechanistic studies of water chemistry would facilitate the development of novel water treatment technologies.
- The development of novel engineered surfaces would be useful in the control of intake and equipment biofouling (e.g. zebra mussels).
- A need to quantify the impact on water quality of mountaintop removal during coal extraction.
- There is also a need for peer review of existing data used in the development of water quality standards, to ensure that available information is adequate to meet the needs of policy and regulatory development, siting issues and appropriate direction of limited resources.
- Water quality issues related to the beneficial use of coal ash & FGD waste, such as ash reclamation of mines along with potential leaching issues in many applications, need to be investigated.